Vital Signs Prioritization

The purpose of this appendix is to give the reader a detailed account of the process through which the Eastern Rivers and Mountains Network (ERMN) prioritized vital signs for implementation in its ecological monitoring program. What follows includes summaries of thought processes and events that occurred in various forms including reports, meetings, telephone calls and emails. This appendix should make the process and transgression of the ERMN's vital signs prioritization completely transparent to the contemporary reader as well as those far into the future.

Introduction

The process for choosing and prioritizing vital signs has been ongoing within the Eastern Rivers and Mountains Network (ERMN) since the fall of 2003 and has been a multifaceted process of park-level scoping workshops, subject matter expert evaluation, a broad vital signs prioritization workshop, park-level rankings, Science Advisory Committee (SAC) review (scheduled for fall 2005), and Board of Directors (BOD) approval (scheduled for fall 2005).

As has been demonstrated by other networks around the country, a formalized and well-documented process for prioritizing vital signs is a necessary and important step in designing a long-term monitoring program. A well-executed and documented prioritization process produces a ranked list of vital signs and: garners broad support from park staffs and scientists outside of the network; guides future dedication of network resources and program development; resolves contemporary conflict related to demands for network resources; and provides documentation on the how and why the network developed as it did for future interested parties.

This appendix serves as documentation of the ERMN prioritization process from the time that network staffs were hired (fall 2003), through the initial generation of a tier-ranked list of final vital signs (fall 2005).

2003 Park Scoping Meetings

To initiate discussion of vital signs, network staff held park-level brainstorm sessions beginning in fall 2003 with each network park's natural resource staff. The purpose of these sessions was to present the Vital Signs program to all interested park staff and draft lists of candidate vital signs based on park input. (For a more detailed account of dates and lists of attendees for workshops and scoping meetings see Appendix L).

The ERMN network coordinator and data manager were both hired new to the NPS in fall of 2003 and along with a Pennsylvania State University research associate attended these 2003 park scoping meetings. As such, the first round of meetings served more as a broad introduction to the parks, their staff, natural resources and management issues. Vital signs were discussed, especially in the context of stressors to park resources of concern and Appendix C serves as a good summary of information gleaned from these scoping meetings and other park management

documents. These meetings served as the genesis for what would become the ERMN "master" list of vital signs.

Phase I Report September 2004

During spring of 2004 the initial national framework for vital signs was made available to networks and based on this list and the cumulative knowledge accrued over the course of the previous year about parks, resources and management concerns, the network published Appendix H as part of its Phase I report to WASO I&M September 2004. This appendix included a list of 57 vital signs applicable to ERMN parks and served as the first master list of vital signs that the network was considering for its monitoring program. The hope was that this master list represented all potential vital signs of ecological and park management interest and significance. What was absent from this list however, was any order or ranking to help guide network staff in how and where they should dedicate resources for future protocol development and implementation.

Science Advisory Committee Meeting December 14, 2004 University Park, PA

In December 2004 the ERMN hosted its first SAC meeting at University Park, PA. After covering introductions to network program and staff and expectations for membership, the principle purpose of the meeting was to discuss conceptual models and vital signs prioritization. (You can see a complete list of attendees to this meeting at the end of this section).

Two existing approaches to prioritizing vital signs and one tool were presented to the group to serve as a starting point and to stimulate discussion. First, an approach recommended to networks by WASO I&M for prioritizing an already developed list of vital signs in one round during a workshop was presented to the group (http://www.nature.nps.gov/im/monitor/PrioritizationExample.doc November 2004). Second, the Mojave Network prioritization (Appendix G Mojave Network Phase I July 2004), was presented as an example of a process that worked well for another network. ERMN staff had been talking to the Mojave Network and playing with their database, so this seemed a natural example to present as a process that had already been implemented. After much discussion and debate the committee arrived at this general work-flow as a suggestion for ERMN prioritization:

- Pare down master list to a more manageable number by subject matter experts based on ecological significance and potential as indicators;
- Hold vital signs prioritization workshop that will serve as peer review of prior step by larger science and NPS community;
- Prioritize short list of vital signs resulting from workshop by park staff based on management significance and legal mandate;
- Integrate park and workshop feedback at network and the SAC level; and
- Allow ERMN Board of Directors to review and approve final, short list of vital signs.

Although discussion during the SAC was very helpful to network staff, it needed further development, as well as the approval of park staffs and the BOD, before it could be implemented.

Science Advisory Committee Members in Attendance for 2004 SAC Meeting

Carolyn G. Mahan Conservation Biologist Pennsylvania State University Altoona Campus 201 ERL Altoona, PA 16601-3760 814 949-5503 cgm2@psu.edu	Duane R. Diefenbach U.S. Geological Survey Pennsylvania Cooperative Fish & Wildlife Research Unit Pennsylvania State University 113 Merkle Lab University Park, PA 16802 814 865-4511 ddiefenbach@psu.edu	David R. Smith Research Ecologist USGS - Leetown Science Center 11649 Leetown Road Kearneysville, WV 25430 304 724-4467 david_r_smith@usgs.gov
Rich Evans Ecologist Delaware Water Gap NRA Division of Research and Planning 294 Milford Road Milford, PA 18337 570 296-6952 x26 Richard_Evans@nps.gov	Beth Johnson Northeast Region I&M Coordinator University of Rhode Island 105 Coastal Institute Kingston, RI 02881 401 874-7060 Beth_Johnson@nps.gov	Jeff Runde Aquatic Ecologist NER/NCR National Park Service National Capitol Region Center for Urban Ecology 4598 MacArthur Blvd, NW Washington D.C. 20007 202 342-1443 x224 Jeff_Runde@nps.gov
Matthew R. Marshall, Ph.D. Ecologist, National Park Service Eastern Rivers and Mountains Network Coordinator 204C Ferguson Building Pennsylvania State University University Park, PA 16802 phone: 814-863-0134 Matt_Marshall@nps.gov	Alan Ellsworth Hydrologist National Park Service Philadelphia Science Office U.S. Geological Survey - WRD 425 Jordan Road Troy, NY 12180-8349 (518) 285-5604 Alan_Ellsworth@nps.gov	John F. Karish NPS Northeast Region Chief Scientist 209B Ferguson Building University Park, PA 16802 814-865-7974 (phone) 267-767-3252 (cell) John_Karish@nps.gov

Non-Science Advisory Committee Members in Attendance for 2004 SAC Meeting

Jennifer Stingelin Keefer Plant Ecology National Park Service Cooperator ERMN MIDN NPSpecies Manager 204D Ferguson Building University Park, PA 16802 814 863-1904 jls227@psu.edu	Holly S. Salazer Regional Air Resources Coordinator Northeast Region National Park Service 207 Buckhout Lab University Park, PA 16802 Phone: (814) 865-3100 Holly_Salazar@nps.gov	Scott Tiffney National Park Service Cooperator NER NatureBib Manager 204D Ferguson Building University Park, PA 16802 814 863-1904 sdt3@psu.edu
Nathan B. Piekielek Ecologist, Data Manager National Park Service Eastern Rivers and Mountains Network 204C Ferguson Building Pennsylvania State University University Park, PA 16802 Phone: 814 863 2320 Nathan_Piekielek@nps.gov	Wayne Millington NPS Northeast Region Integrated Pest Management Specialist 209A Ferguson Building University Park, PA 16802 Phone: 814 863 8352 Wayne_Millington@nps.gov	Michele J. Batcheller NPS Northeast Region Regional Wildlife Biologist 209C Ferguson Building University Park, PA 16802 Phone: 814-863-9414 Michele_Batcheller@nps.gov

Proposed Vital Signs Prioritization Process

Following the SAC meeting in December 2004, ERMN staff spent several intense days in January 2005 further developing a proposed prioritization process for the network. They borrowed heavily from reports written by other networks that had already gone through the process, as well as developing unique aspects to fit the ERMN. The agreed upon process was written up and distributed to parks, and approved by the ERMN BOD in January 2005 in advance of a second round of park scoping meetings planned for later that month. The following text is the proposed process that was distributed:

DRAFT *JANUARY 4, 2005*

EASTER RIVERS AND MOUNTAINS NETWORK

VITAL SIGNS PRIORITIZATION PROCESS

SUMMARY:

Network vital sign prioritization is one of the most important steps in the NPS Inventory and Monitoring (I&M) Program's planning process as it guides the remainder of program development. As such, the ERMN sought the input of its Science Advisory Committee (SAC) during a meeting held December 14, 2004 at University Park, PA. The SAC and network staff spent the majority of the meeting discussing the vital signs prioritization process, hearing from members of the group that had been through the process in affiliation with other networks, and arriving at consensus on how to proceed. It was decided that the ERMN would generally follow proposed methods of prioritization by the national I&M program which incorporate ecological significance and management significance/legal mandate to prioritize vital signs. Though some details were left to be determined at a later date, the following represents the general process and workflow that the SAC suggested for the ERMN.

The ERMN proposes to accomplish its vital signs prioritization in six steps:

1. Generation of a vital signs long list via park scoping process;
2. Paring down of long list to a more manageable number by subject matter experts based on ecological significance and value as indicators;
3. Vital signs prioritization workshop that will serve as peer review of step 2 by larger science community; (**Target date for workshop is during the week of May 16 at Penn State**)
4. Prioritization of final short list of vital signs from step 3 by park staff based on management significance and legal mandate;

5. Integration of park and workshop feedback and resolution of ambiguity will be handled by network staff and the ERMN Science Advisory Committee.
6. ERMN Board of Directors will approve final, prioritized list of vital signs.

The purpose of this prioritization is to identify at the onset vital signs that the network considers most important without considering in detail the methods of measurement or their feasibility. The ranking is not intended to establish a numerical order in which vital signs will be implemented. For many vital signs, feasibility is closely tied to sampling design and will be addressed during Phase 3 planning.

**Before this process is implemented it will be presented to park staff during individual park visits in January 2005. Any feedback will be incorporated and the ERMN will seek formal approval of the prioritization process (NOT the vital signs list) from its Board of Directors by late January/early February.*

DETAILED DESCRIPTION OF THE PRIORITIZATION PROCESS:

Step 1: Generation of the ERMN Vital Signs "Long List"
Appendix H of the ERMN Monitoring Plan was meant to represent the draft "long list" of potential vital signs for the network and was submitted along with Phase 1 reporting in October 2004. The list has subsequently been revised and expanded (December 2004). The generation of this list was achieved primarily through the series of park scoping meetings (Fall 2003/Winter 2004) by network staff to discuss park resources, management issues and species or communities of special concern, but also through the review of park Resource Management Plans, Water Management Plans, and other reports and relevant documents; results of the Geologic Resource Evaluations (Summer 2004); discussions with and reports by ERMN cooperators; and any planned or opportunistic discussions with Park natural resource staff as well as Regional and I&M staff. The initial draft of this long list, in essence, was the best attempt by Network staff to assimilate and interpret all the information gained on Park resources and potential monitoring needs during the formulation of the Phase 1 Report.

However, due to the importance of the completeness of Appendix H, Network staff will solicit additional vital signs input from parks during a series of January 2005 park visits. The purpose of these visits will be to review and discuss the ERMN Phase 1 Report, the prioritization process, the long list of vital signs and associated monitoring objectives, and to allow the parks additional opportunity to add vital signs to the long list. It is anticipated that there will be revisions to Appendix H during these meetings but once all parks have provided input, this will be treated as the final long list of vital signs for the network.

Step 2: Ecological Significance I -- Subject Matter Experts evaluate and reduce "long list". Natural resources in the ERMN have been separated into three generic ecosystem types (which follow the conceptual models presented in Chapter 2 of the Monitoring Plan), with obvious overlap between them: 1. Terrestrial Ecosystems; 2. Large River Ecosystems; 3. Tributary Watershed Ecosystems. Network staff will solicit a Subject Matter Expert for each ecosystem type with significant expertise in the area and familiarity with appropriate ecological indicators. This subject matter expert will evaluate each vital sign currently on the long list and ultimately reduce the long list to a more manageable list of potential vital signs based on ecological significance and value as an indicator.

One of the major challenges of the vital signs prioritization process is one of presentation. It has been well demonstrated that participants in human-subjects social science research struggle to rank or order long lists of items in a way that makes sense and accurately represents their beliefs and values (*add citations*). Methods such as pair-wise comparisons can present items to participants in a manner that are more manageable, however when lists become long this can still be an involved and resource intensive task. For this reason, any ordinal ranking or prioritization of the +/-60 vital signs identified in Appendix H would be laborious, difficult and may not yield reliable or repeatable results. What's more, park staffs have many responsibilities and therefore limited time to participate in the I&M planning process. Finally, there was general consensus within the SAC due to limited resources that in the end, the network would only be able to monitor the most obvious, relevant, and scientifically supported (i.e., "no-brainer") vital signs (along with perhaps a few others). Furthermore, the "no-brainer" vital signs based solely on ecological significance could be identified by most subject matter experts even with limited

specific knowledge of network/park resources. It was therefore decided that network staff should work with subject matter experts to pare down the long list presented in Appendix H to a more manageable number of vital signs before seeking park input on prioritization.

Subject matter experts will be provided the long list of vital signs relevant to their respective system (Large Rivers, Tributary Watershed, Terrestrial Systems), chapters 1 and 2 of the ERMN Monitoring Plan along with park resource overviews from network staff. Experts will be asked to evaluate each vital sign based on the following criteria and their own expert opinion. These prioritization criteria have been modified from other national programs, including other NPS Vital Sign Monitoring Networks:

Ecological Significance:

- There is a strong, defensible linkage between the vital sign and the ecological function or critical resource it is intended to represent.
- The vital sign represents a resource or function of high ecological importance based on the conceptual model of the system and the supporting ecological literature.
- The vital sign provides early warning of undesirable changes to important resources. It can signify an impending change in the ecological system.
- The vital sign is sufficiently sensitive to detect specified change; has a high signal to noise ratio and does not exhibit large, naturally occurring variability.

The subject matter expert will also be tasked with reviewing relevant literature and to further develop the conceptual ecosystem models illustrating the linkages between vital signs and ecosystem process, function or effect. Based on their literature review and modeling exercises they will choose a subset of vital signs that are most relevant, ecologically significant and feasible indicators of natural resource condition in network parks. They will write up a fully cited narrative supporting their proposed vital signs. It is anticipated that this narrative will serve both as justification for their vital signs selection as well as a narrative explaining the linkages of vital sign within the conceptual ecosystem models.

This “working short list” of vital signs generated by subject matter experts along with the justification narratives will be presented to park staff for review and as another effort to seek their input, involvement and approval of this process. Any pressing issues (e.g., concerns about vital signs not on the working short list) can be discussed prior to the next step of the prioritization process, the workshop.

Step 3: Ecological Significance II - Vital Signs Prioritization Workshop

During the spring/early summer of 2005 network staff will hold a vital signs prioritization workshop (**Target date is during the week of May 16 at Penn State University**). Much of the workshop will be organized around the three ecosystem types with breakout groups for each led by the subject matter experts who did the initial paring down of vital signs. This workshop will provide an opportunity for subject matter experts to present their work (justification for the chosen short list of vital signs and linkages to the conceptual models) to peers in the scientific community, and an opportunity for the scientific community to participate in the vital signs prioritization process of the ERMN. During this workshop the current working list of vital signs may be added to, deleted from or substitutions may be made depending on group process, discussion and consensus. The workshop will be separated into two sections: 1. To reach scientific consensus and finalize a short list of vital signs for the ERMN; 2. To evaluate the merits of individual vital signs and priority group them accordingly.

Subject matter experts will have the opportunity to present their vital signs list and justification to their peers during the first section of the workshop. Following their presentation they will field questions from the group and facilitate/moderate discussion. If network staff has done a good job of inviting a diverse and qualified group of scientists to the workshop there should be lively debate of the short list of vital signs, but also consensus on the appropriate vital signs to consider further. Further discussion and modification of the conceptual ecological models will take place simultaneously. Attendees of the workshop will be encouraged to participate and propose additions, deletions or substitutions to the short list of vital signs and changes to the models. Having already had their chance to make their case for their proposed vital signs, the subject matter experts serving as group facilitators will be charged with guiding discussion and seeking out consensus in the group. The result of this section of the workshop will be a short list

of vital signs for each ecosystem type upon which there is scientific consensus among workshop attendees.

The second part of the workshop will involve prioritizing each vital sign on the working short list described above into one of three categories. Each category will have a numerical value associated with it (3=High, 2=Medium, or 1=Low Priority) that will used to integrate with the park management significance ranking (described below). Decisions will be made by consensus of the work group.

Some vital signs will be considered in more than one workgroup (i.e., Weather and Climate; Water Quality – Core Parameters) and may be ranked differently in each workgroup. In these cases, the vital sign will be brought before all participants in the workshop for discussion and final consensus on its rank.

Throughout the workshop there will be opportunities for breakout groups to interact with one another and for attendees to give the ERMN general feedback on vital signs, prioritization, planning, existing monitoring programs and any other wisdoms that their expertise might lend; the more outside interest and involvement in the ERMN monitoring program that can be stimulated during this workshop, the better monitoring program the network will be able to design and implement.

The final result of the ERMN vital signs prioritization workshop will be a priority grouped (high, medium, and low priority) list of vital signs based on ecological significance that has been peer-reviewed, is justifiable, supported by conceptual ecosystem models, and upon which there is general scientific consensus.

Step 4: Park Prioritization based on Management Significance and Legal Mandate

Following the prioritization workshop, ERMN staff will compile the finalized short list of network vital signs and solicit input from park staff once again. Parks will be presented with the short list of vital signs from all three ecosystem types resulting from the workshop and asked to prioritize these vital signs according to management significance and legal mandate. Parks will

not be presented with results of the priority groupings based on ecological significance done at the workshop. Evaluation of each vital sign in terms of Management Significance will be according to the following criteria (again based on other national programs, including other NPS Vital Sign Monitoring Networks):

Park Management Significance

- **Legal/policy mandate**: How important is monitoring this resource/vital sign for satisfying legal or policy mandates? [3=high importance (required), 2=moderate importance (specifically identified), 1=low importance (generally identified)]
- **Potential to support management decisions**: Does monitoring this vital sign directly link to the information needed for carrying out a key management decision or evaluating the outcome of a management decision? [3=strong application, 2=moderate application, 1=weak application]
- **Importance of resource management**: How important (for management) is the resource or issue represented by the vital sign, relative to other resources or issues in the park? [3=high importance, 2=moderate importance, 1=low importance]
- **The indicator will produce results that are clearly understood and accepted** by park managers, other policy makers, and the general public, all of whom should be able to recognize the implications of the indicator's results for protecting and managing the park's natural resources. [3=clearly understood, 2=generally understood, 3=poorly understood]

The I&M program is a park-based program who's chief mission is to provide information to park managers on the status, conditions and trends of park natural resources (see I&M document citation). For this reason ERMN network staff have concluded that park staff will be provided an opportunity to respond for *each* park that they help to manage (i.e. managers who have shared duties among multiple parks will be asked to submit multiple prioritizations). However, because the network is interested in one unified voice from each park, in parks where there exist multiple natural resource staff they must synthesize their knowledge and understanding of park resources to submit only one prioritization for the park (not from each member of the staff). ERMN

network staff will be available to provide neutral facilitation of this park based prioritization process if their assistance is specifically requested by park staffs.

The final result of park vital sign prioritization will be a three class priority grouped list of vital signs based on management significance/legal mandate for each individual park.

Step 5: Integration and resolution of final prioritization

Upon receiving all of the results of the park prioritization process, network staff will integrate this information with the results of the vital signs prioritization workshop. The final ranking of vital signs will be weighted evenly between the results of the Workshop (50% Ecological Significance) and the park rankings (50% Management Significance). The ecological significance value is a straight forward 3, 2, or 1 based on High, Medium, or Low priority, respectively. The final value for management significance will be the result of two rounds of averaging. The first round of averaging will take the score from the 4 criteria such that each park will have an average value/rank for each indicator based on the 4 criteria outlined above. The second round of averaging will be among all nine ERMN parks for each vital sign.

Finally, the ecological significance value and the park management significance value will be averaged. (This process will be automated via the database format we will implement). The final, prioritized list of vital signs will be reviewed by the Science Advisory Committee with any discrepancies and ambiguities addressed.

Step 6: Approval of prioritized vitals signs by ERMN Board of Directors

This list will then be presented to the Board of Directors for final approval. Again, the purpose of this prioritization is to identify at the onset vital signs that the network considers most important without considering in detail the methods of measurement or their feasibility. The ranking is not intended to establish a numerical order in which vital signs will be implemented (and “ties” are OK). For many vital signs, feasibility is closely tied to sampling design and will be addressed during Phase 3 planning.

Winter 2005 Park Scoping Meetings

In addition to the write-up of the proposed prioritization process, network staff presented the proposed process to park staff in person during a second round of park scoping meetings in winter 2005. Park staff was encouraged to give input to the process and make suggestions, although few were received and the proposed process remained almost unchanged after these meetings. There was consensus that the process was fair and appropriate and that the network should proceed with vital sign prioritization.

In addition to consensus on a process for vital signs prioritization, this round of park scoping meetings was also meant to complete the master list of vital signs that the network was considering for its program and that would enter into the prioritization process. In this new and far clearer context that these were the vital signs being considered for prioritization and therefore implementation, discussion of park vital signs was rich and revealing. Vital signs were added to the master list, taken off, lumped, split, added to some parks and taken away from others. Following these park scoping meetings network staff were confident that they had captured all of the vital signs of interest to park staffs and represented them as best as possible in the master list of vital signs with which to initiate the prioritization process.

Core Planning Team Formation

The next stage in refining the list of vital signs involved forming a core team of subject matter experts to shorten the list of vital signs based on a literature review and best professional judgment. Network staff felt that in order to have a rich and fruitful prioritization workshop it was necessary to present to the group a manageable number of vital signs (fewer than the 57 on the master list), to focus discussion and consideration. What's more, attendees of the workshop would have the liberty of adding, or removing vital signs from consideration so if members of the core planning team had made any gross omissions or including a vital sign that was really not worth consideration, there was room to bring those vital signs back into the process.

ERMN resources were separated into three dominant ecosystem types: large rivers, terrestrial, and tributary stream watersheds and subject matter experts were solicited for each. A request for proposals/statement of work was circulated to several qualified individuals who had been identified by SAC members during the December 2004 SAC meeting. The following text is what was circulated and provides more detail on the role of core planning team members and expectations for their membership.

National Park Service
United States Department of the Interior
Matthew R. Marshall, Ecologist
Eastern Rivers and Mountains Network Coordinator
204C Ferguson Building
University Park, PA 16802
814/863-0134
Matt_Marshall@nps.gov

EASTERN RIVERS AND MOUNTAINS NETWORK

INITIAL VITAL SIGN EVALUATION, SELECTION, AND JUSTIFICATION

Request for Proposal / Statement of Work

Background

The National Park Service (NPS) mission, to preserve, protect, and maintain the health of park ecosystems for the enjoyment of future generations, relies upon access to science-based information regarding the status and trends of ecosystem health. Parks have a critical need to know the condition of natural resources in order to meet the basic goal of preservation. To address this need, the NPS implemented a new strategy to conduct a service wide Inventory and Monitoring Program (a.k.a., the Vital Signs Monitoring Program). The purpose of this program is to develop broadly based, scientifically sound information on the current status and long-term trends in the composition, structure and function of park ecosystems.

The implementation of this program is based on “Networks” or groups of parks. The Eastern Rivers and Mountains Network (ERMN) includes nine parks located in four states: New York, New Jersey, Pennsylvania, and West Virginia. The ERMN parks range in size from approximately 66 to 30,000 hectares and generally consist of a mosaic of forested hillsides and floodplains, streams and large rivers, tallus slopes and cliffs, vernal pools and wetlands, open fields and agriculture. These parks are not immune to a variety of natural and anthropogenic disturbances that affect, or have the potential to affect, park resources. Primary resource threats include invasive plants and animals, degradation of water quality from a variety of sources, atmospheric deposition, and urbanization and land use change around park property. Knowing the status and long-term trend of park natural resources and potential stressors is fundamental to protecting and managing National Park Service lands.

Monitoring provides site-specific information useful for understanding and identifying change in complex, variable, and imperfectly understood natural systems and for determining whether observed changes are within natural levels of variability or may be indicators of unwanted human or natural influences. The intent of the NPS Vital Signs Monitoring program is to track a subset of park resources and processes that are determined to be the most significant indicators of ecological condition of those specific resources that are of the greatest concern to each park.

The 5 service-wide goals for the NPS Vital Signs Monitoring Program are to:

- Determine status and trends in selected indicators of the condition of park ecosystems to allow managers to make better-informed decisions and to work more effectively with other agencies and individuals for the benefit of park resources.
- Provide early warning of abnormal conditions for selected resources to help develop effective mitigation measures and reduce costs of management.
- Provide data to better understand the dynamic nature and condition of park ecosystems and to provide reference points for comparisons with other, altered environments.
- Provide data to meet certain legal and Congressional mandates related to natural resource protection and visitor enjoyment.
- Provide a means of measuring progress towards performance goals.

Project Summary

The primary focus of this project is to assist in the identification of these indicators by further developing conceptual ecological models and diagrams, proposing a parsimonious suite of integrated ecological indicators (from an *a priori* list with freedom to add to the existing list), and developing a clear justification for the indicators selected. Subject matter experts should be mindful of cost considerations and recognize that we are building modest program and, as such, the chosen indicators need to have strong ecological relevance and sensitivity and serve a foundational role in the monitoring program.

Based on a series of park-based scoping sessions, a draft "long-list" of potential vital signs/indicators has been generated for each of three broad, ecosystem types (Large Rivers, Tributary Watersheds, and Terrestrial Ecosystems). The Cooperator(s) will be asked to serve as a "subject matter expert" for one of these systems and evaluate the **ecological significance** of each vital sign based on the following criteria and their own expert opinion. These prioritization criteria have been modified from other national programs, including other NPS Vital Sign Monitoring Networks:

Ecological Significance:

- There is a strong, defensible linkage between the vital sign and the ecological function or critical resource it is intended to represent.
- The vital sign represents a resource or function of high ecological importance based on the conceptual model of the system and the supporting ecological literature.
- The vital sign provides early warning of undesirable changes to important resources. It can signify an impending change in the ecological system.
- The vital sign is sufficiently sensitive to detect specified change; has a high signal to noise ratio and does not exhibit large, naturally occurring variability.

The subject matter expert will be tasked with reviewing relevant literature and to further develop the conceptual ecosystem models and diagrams that illustrate the linkages between vital signs and ecosystem process, function or effect. Based on their literature review and modeling exercises they will choose a subset of vital signs that are most relevant, ecologically significant and feasible indicators of ecosystem condition in network parks. They will write up a fully cited narrative supporting their proposed "short list" of vital signs. It is anticipated that this narrative

will serve both as justification for their vital signs selection (example narratives below) as well as a narrative explaining the linkages of vital sign within the conceptual ecosystem models. This list will not be ranked, but will simply be a "short-list" of appropriate vital signs based on ecological significance for further evaluation and subsequent prioritization.

During the spring of 2005 network staff will hold a vital signs prioritization workshop (**Date for workshop is May 19-20 at Penn State University**). Much of the workshop will be organized around three ecosystem types with breakout groups for each led by the subject matter experts who did the initial paring down of vital signs. This workshop will provide an opportunity for subject matter experts to present their work (justification for the chosen short list of vital signs and linkages to the conceptual models) to peers in the scientific community, and an opportunity for the scientific community to participate in the vital signs prioritization process of the ERMN. During this workshop the current working list of vital signs may be added to, deleted from or substitutions may be made depending on group process, discussion and consensus. The workshop will be separated into two sections: 1. To reach scientific consensus and finalize a short list of vital signs for the ERMN; and 2. To evaluate the merits of individual vital signs and priority group them accordingly.

The final result of the ERMN vital signs prioritization workshop will be a priority grouped (high, medium, and low priority) list of vital signs based on ecological significance that has been peer-reviewed, is justifiable, supported by conceptual ecosystem models, and upon which there is general scientific consensus.

For additional information on the Eastern Rivers and Mountains Network and the National Inventory and Monitoring Program, please refer to the following websites:

http://www1.nature.nps.gov/im/units/ermn/index.htm
http://science.nature.nps.gov/im/index.htm

To view/download the Eastern Rivers and Mountains Network Draft Monitoring Plan please refer to the following website:

http://www1.nature.nps.gov/im/units/ermn/monitoring.htm#MonitoringPlan

It is recommended that Subject Matter Experts review the Executive Summary and Chapter 1 for general information as well as Appendix A, F, and G for additional; information on the Parks and important resources, air quality and water quality.

Project Goals and Objectives

Involvement with and products expected from this project include but are not limited to:

1) Further development of conceptual ecosystem models and diagrams including:
   - Identification of key ecosystem processes and functions that best indicate ecosystem integrity.

- Incorporation of known or hypothesized ecological effects of stressors to ecosystems in the Eastern Rivers and Mountains Network parks.
- (Construction of the proposed conceptual models and diagrams will be done with an NPS cooperator with experience in graphic design and desktop publishing)

2) Conduct an evaluation, and select a subset, of existing ERMN Vital Signs based on a thorough literature review and expert opinion. Write fully cited narrative supporting the decisions made. Decision should be based on the stated goals of the monitoring program (listed above), ecological significance criteria (listed above), and relevance to ERMN parks and the issues they face. Example narratives below.

3) Assistance in planning, developing, and facilitating the May 2005 Vital Signs Prioritization Workshop including:
   - Moderation/Facilitation of appropriate break out group of the Workshop.
   - Presentation of conceptual models and selected vital signs from task 2 above.
   - Writing summary report of Workshop results.

Send proposals (and direct questions) to:

Matthew R. Marshall, Ecologist
Eastern Rivers and Mountains Network Coordinator
204C Ferguson Building
University Park, PA 16802
814/863-0134
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DRAFT Example Narratives – these should be considered brief narratives. I expect the final product to be somewhat longer and, most importantly, include many more citations.

Vital Sign 4: Weather and Climate
BRIEF DESCRIPTION: Basic climatological measurements include: temperature (maximum, minimum and average), multiple forms of precipitation, wind (direction and speed), relative humidity, and snow depth.
SIGNIFICANCE/JUSTIFICATION: Because climate is a basic driver of all ecological systems, these measurements are important for understanding the relationship between climate and other components of biotic and abiotic systems. Without climate data, it is impossible to appreciate the causes of a variety of ecosystem changes—from vegetative cover changes to shifts in aquatic systems. In fact, the most important components of useful climatological measurements are the length and accuracy of the data. Maintenance of climate stations, therefore, is extremely important in order to assure high-quality data.
PROPOSED METRICS: Air temperature (maximum, minimum and average), variety of precipitation measurements, surface wind (direction and speed), and relative humidity.
PROSPECTIVE METHOD(S) AND FREQUENCY OF MEASUREMENT: Rely almost exclusively on existing sources or weather/climatological data made relevant to ERMN parks and ecosystems. Essentially a data management task. Frequency: generally hourly average, max, and min
LIMITATIONS OF DATA AND MONITORING: Tremendous amounts of data available regionally, but perhaps difficult to make relevant to network parks (and manage).
KEY REFERENCES:

Stenseth, N. C., A. Mysterud, G. Ottersen, J. W. Hurrell, K.-S. Chan, and M. Lima, 2002: Ecological effects of climate fluctuations. *Science,* 297, 1292-1296.
RELATED ENVIRONMENTAL ISSUES AND LINKED VITAL SIGNS: Climate is related to all other physical and biological issues and vital signs.
OVERALL ASSESSMENT: It is essential to understand the influence of climate variability on biotic and abiotic systems.

Vital Sign 13: Surface water hydrology – streams and rivers
BRIEF DESCRIPTION: Refers to the volume of water passing a point of reference (discharge) and varies with precipitation, other climatic factors, and basin characteristics.
SIGNIFICANCE/JUSTIFICATION: Streamflow/Riverflow directly reflects climatic variation. Stream systems play a key role in the regulation and maintenance of biodiversity. Changes in streams and streamflow are indicators of changes in basin dynamics and land use.
PROPOSED METRICS: Discharge or gauge / stage height
PROSPECTIVE METHOD(S) AND FREQUENCY OF MEASUREMENT: There are standard techniques for measuring flow. Where more quantitative data are not available, study of changes in biomass distribution (especially woody plants) can provide reliable qualitative measures of hydrologic and geomorphic events spanning the past several hundred years
LIMITATIONS OF DATA AND MONITORING: Streams/rivers at floodstage and at very low water levels are difficult to gauge. The effectiveness of water flow as an indicator depends strongly on a well-designed, systematic network of monitoring stations.
KEY REFERENCES:
Baker, V.R., R.C.Kochel and P.C.Patton (eds.) 1988. *Flood geomorphology* . New York: John Wiley and Sons.
Osterkamp, W.R. and S.A.Schumm 1996. Geoindicators for river and river-valley monitoring. In Berger, A.R. and W.J.Iams (eds.). *Geoindicators: Assessing rapid environmental changes in earth systems* :83-100. Rotterdam: A.A. Balkema.
Wolman, W.G. and H.C.Riggs 1990. *Surface water hydrology* . The Geology of North America, Volume 0-1, Boulder, CO: Geological Society of America.
RELATED ENVIRONMENTAL ISSUES AND LINKED VITAL SIGNS: Streamflow affects virtually all other environmental issues connected with water.
OVERALL ASSESSMENT: Streamflow is of fundamental importance to virtually all environmental monitoring.

Core Planning Team Formation (Cont.)

As a result of the above solicitation, the ERMN formulated a core planning team which was divided into three ecosystem types. Two of the three teams were simultaneously drafting or revising the network conceptual models as well and therefore could use all of the insights gained from that process to inform their recommended short-list of vital signs.

Core Planning Team Members and Affiliation by Ecosystem Type

Ecosystem Type	Core Planning Team Membership	Member Affiliation
Large River	William A Lellis Robert Ross Martin DiLauro	USGS Leetown Science Center, Northern Appalachain Research Lab
Tributary Watershed	Robert P Brooks Craig Snyder Mark Brinson (East Carolina Univ)	Pennsylvania State University Cooperative Wetlands Center; USGS Leetown Science Center
Terrestrial	Ray R Hicks Jr. James S Wrench Stockton Maxwell	Forest Ecology West Virginia University

Core Planning Team Meeting April 21, 2005 Universtiy Park, PA

In spring of 2005 the ERMN assembled it's newly formed core planning team at University Park to discuss their progress on paring down the master list of vital signs, as well as the upcoming vital signs prioritization workshop. Core planning team members brainstormed prospective workshop participants and network staff generated an announcement that was distributed accordingly. The announcement along with other workshop materials can be viewed on the ERMN Network Workshop webpage:
(http://www1.nature.nps.gov/im/units/ermn/workshop.htm)

Vital Signs Prioritization Workshop May 19-20, 2005 University Park, PA

On May 19-20, 2005 network staff held a vital signs prioritization workshop at Pennsylvania State University that included 51 professionals with diverse backgrounds and expertise including all member of the ERMN SAC and at least one representative from each ERMN park (you can view a complete list of workshop attendees at the end of this section). The workshop was organized around the dominant ecosystem types with working groups for each led by the core team of subject matter experts who did the initial paring down of the master list of vital signs. This workshop provided an opportunity for the core planning team of subject matter experts to present their work (justification for paring down the master list of vital signs and development of

linkages to the conceptual models) for review by peers in the scientific community, and an opportunity for the scientific community to participate in the vital signs prioritization process of the network. During this workshop the current pared down list of priority vital signs (the short list) could have been modified (additions/subtractions/etc.) depending on group process, discussion and consensus.

The workshop was designed to meet two objectives. The first objective was to reach scientific consensus on a proposed short list of priority vital signs for the ERMN. The second objective was to further evaluate the merits of individual vital signs and priority group them into "tiers" for implementation (with "tier-1" being the highest priority vital signs for protocol development and implementation and "tier-3" the lowest).

The final result of the ERMN vital signs prioritization workshop was a short-list of tier-ranked vital signs based on ecological significance that had been peer-reviewed, is justifiable, supported by conceptual ecosystem models, and upon which there is general scientific consensus.

The workshop participants started with 36 candidate vital signs, dropped 3 from further consideration (White-tailed Deer, Mosses Lichens and Bryophytes, and Phenology), added two new vital signs (Indicator Taxa and Terrestrial Mammals), and also lumped and split several vital signs. In the end, the workshop ended with the same number (36) of vital signs although some were different than when they began. (See table K.1 for a complete list of workshop vital signs tier rankings).

Eastern Rivers and Mountains Network
Vital Signs Prioritization Workshop
May 19-20, 2005
Penn Stater Hotel and Conference Center
Penn State University
State College, PA

Workshop Participants

Terrestrial Ecosystems Working Group

John Perez Biologist National Park Service New River Gorge National River P.O. Box 246 Glen Jean, WV 25846-0246 John_Perez@nps.gov 304 465-6537	Ray R. Hicks Jr. Forest Ecology West Virginia University 337C Percival Hall PO Box 6125 Morgantown, WV 26506 rhicks3@wvu.edu 304 293- 2941 x2424	John S. Strazanac Entomologist West Virginia University Agricultural Sciences Building G162 PO Box 6108 Morgantown, WV 26506 jstrazan@wvu.edu 304 293-6023 x4302
Jeff Shreiner Biologist Delaware Water Gap NRA Division of Research and Planning 294 Old Milford Road Milford, PA 18337 Jeffrey_Shreiner@nps.gov 570 296-6952 x28	James S. Rentch Forest Ecologist West Virginia University 329 Percival Hall PO Box 6125 Morgantown, WV 26506 jrentch2@wvu.edu 304 293-2941 x2480	Carolyn G. Mahan Conservation Biologist Pennsylvania State University Altoona Campus 201 ERL Altoona, PA 16601-3760 cgm2@psu.edu 814 949-5503
Geri Tierney Environmental & Forest Biology SUNY College of Environmental Science & Forestry 1 Forestry Drive Syracuse, NY 13210 gtierney@esf.edu 607-257-5369 or 315-470-6754	Stockton Maxwell Forest Ecologist West Virginia University 385 Evans Street Morgantown, WV 26505 smaxwell79@hotmail.com 304 242-4087	Alan H. Taylor Geography Pennsylvania State University 302 Walker Building University Park, PA 16802 aht1@psu.edu 814 865-3433

Terrestrial Ecosystems Working Group continued

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Nancy Brown Landscape Architect Cultural Resources National Park Service, Northeast Region, Philadelphia, PA Nancy_J_Brown@nps.gov 617 597-8863	Lisa Williams Wildlife Biologist Pennsylvania Game Commission – Wildlife Diversity Section liswilliams@state.pa.us 814 349-7299	Duane R. Diefenbach U.S. Geological Survey Pennsylvania Cooperative Fish & Wildlife Research Unit Pennsylvania State University 113 Merkle Lab University Park, PA 16802 ddiefenbach@psu.edu 814 865-4511
Tonnie Maniero Air Quality Ecological Effects Coordinator Northeast Region National Park Service 15 State Street Boston, MA 02109 Tonnie_Maniero@nps.gov 617 223-5383	Douglas A. Miller Director, Center for Environmental Informatics Pennsylvania State University 2217 Earth-Engineering Sciences University Park, PA 16802 miller@eesi.psu.edu 814 863-7207	Jim Comiskey National Park Service Mid-Atlantic Network Coordinator Fredericksburg & Spotsylvania National Military Park 120 Chatham Lane Fredericksburg, VA 22405 Jim_Comiskey@nps.gov 540 654-5328

Tributary Watershed Ecosystems Working Group

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Connie Ranson Natural Resource Specialist Fort Necessity National Battlefield/ Friendship Hill NHS One Washington Parkway Farmington, PA 15437 Connie_Ranson@nps.gov 724 329-5818	Scott Sheeder Hydrology and Aquatic Ecology Pennsylvania State University 1 Land and Water Building University Park, PA 16802 sas371@psu.edu 814 863-5541	David R. Smith Research Ecologist USGS - Leetown Science Center 11649 Leetown Road Kearneysville, WV 25430 david_r_smith@usgs.gov 304 724-4467
Rich Evans Ecologist Delaware Water Gap NRA Division of Research and Planning 294 Milford Road Milford, PA 18337 Richard_Evans@nps.gov 570 296-6952 x26	Hunter Carrick Aquatic Ecology Pennsylvania State University 8 Ferguson Building University Park, PA 16802 hjc11@psu.edu 814 865-9219	Mark M. Brinson Ecosystem and Wetland Ecology East Carolina University BS-408 Greeneville, NC 27858 brinsonm@mail.ecu.edu 252 328-6307
Beth Johnson Northeast Region I&M Coordinator University of Rhode Island 105 Coastal Institute Kingston, RI 02881 Beth_Johnson@nps.gov 401 874-7060	Jennifer Stingelin Keefer Plant Ecology National Park Service Cooperator ERMN MIDN NPSpecies Manager 204D Ferguson Building University Park, PA 16802 jls227@psu.edu 814 863-1904	Karin E. Limburg Aquatic Ecology 249 Illick Hall SUNY-ESF 1 Forestry Drive Syracuse, NY 13210 klimburg@esf.edu 315 470-6741
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Tributary Watershed Ecosystems Working Group continued

Susan E. Laubscher Aquatic Ecology Cooperative Wetlands Center Pennsylvania State University University Park, PA 16802 sel131@psu.edu 814 863-3208	Kristina Callahan National Park Service Mid-Atlantic Network Data Manager Fredericksburg & Spotsylvania National Military Park 120 Chatham Lane Fredericksburg, VA 22405 Kristina_Callahan@nps.gov 540 654-5538	

Large River Ecosystems Working Group

Jesses Purvis Fisheries Biologist National Park Service New River Gorge National River P.O. Box 246 Glen Jean, WV 25846-0246 Jesse_Purvis@nps.gov 304 465-6513	Pete Penoyer Hydrologist National Park Service Water Resources Division 1201 Oak Ridge Drive, Suite 250 Fort Collins, CO 80525 Pete_Penoyer@nps.gov 970 225-3535	William A Lellis Branch Chief USGS Leetown Science Center Northern Appalachian Research Laboratory 176 Straight Run Road Wellsboro, PA 16901 wlellis@usgs.gov 570 724-3322 x222
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Large River Ecosystems Working Group continued

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George E. Schuler Director NY Delaware River Basin Program The Nature Conservancy P.O. Box 617 Cuddebackville, NY 12729 GSchuler@tnc.org 845 858-2883		

Post Workshop Activities

Following the prioritization workshop core planning team members were asked to write a short report on the workshop for each of their ecosystem groups. They were provided this guidance via email to structure the reports:

Eastern Rivers and Mountains Network
May 19-20 Vital Sign Prioritization Workshop
Penn State University

Workshop Report Guidelines

My goal is to produce a stand-alone document that summarizes the workshop. This document will also include the work you guys did leading up to the workshop (writing of narratives, etc.) and any post workshop revisions to narratives, etc. I will write the introductory sections that outline the ERMN Prioritization Process, which includes how we generated the candidate list, and the two steps that involved you guys. The first is your review of the ERMN candidate list, narrowing to short list of high priorities, and writing of narratives. The second is the workshop itself. I will write about the workshop location, date, structure, agenda and participants. Stuff like that.

I would like you guys to structure your "workshop reports" in three sections: 1. Work you did prior to the workshop, 2. The workshop itself, and 3. Anything done post-workshop.

1. Work prior to workshop

1a. You were asked to review our candidate list vital signs and shorten this list to a subset of "high priority vital signs" based on the following criteria and best professional judgment.

Ecological Significance:

- There is a strong, defensible linkage between the vital sign and the ecological function or critical resource it is intended to represent.
- The vital sign represents a resource or function of high ecological importance based on the conceptual model of the system and the supporting ecological literature.
- The vital sign provides early warning of undesirable changes to important resources. It can signify an impending change in the ecological system.
- The vital sign is sufficiently sensitive to detect specified change; has a high signal to noise ratio and does not exhibit large, naturally occurring variability.

1b. Create a table showing the vital signs you considered (i.e., the subset of 61 vital signs that were relevant to your ecosystem group).

1c. Which vital signs you chose any why. And the process by which you made these decisions. Some of you started with a general conceptual model, others thought more strictly about stressors, etc. I envision this section as a means to illustrate your thinking on how you tackled this assignment. Did you consult with others, if so, who. Literature review, etc.

1d. Indicate in the table which ones you deemed to be high priorities and state that a draft narrative was written for each.

For example:

Table xx. ERMN candidate vital signs for consideration by XX Ecosystem working group.

Level 1	Level 2	Level 3 "Vital Sign"
Air and Climate	Air Quality	Air Chemistry – Ozone (VS1)
Etc.		

2. Workshop.

2a. Introductions of breakout groups at workshop. Somehow recap what you wrote in section 1c since this is what each of started the workshop with. Basically, workshop participants were provided with the narratives and the overall list of ERMN Vital Signs. And you set the stage for discussion…how?

2b. Summarize what additions and deletions were made to the shortlist of high priorities during your workgroup. Again, a table would be good show what the final short list looked like. What issues came up and why were these additions and deletions made.

2c. Summarize the thought process and means by which you identified tier 1-3 rankings. Did you vote? Did you vote more than once? Did you do it by consensus? What were the key issues, discussions, and major hurdles. This is NOT meant to be the minutes of your workgroup, rather a summary of the big issues, ideas and developments.

2d. Display, probably in the same table, what the final tier-ranks look like.

3. Post Workshop.

3a. Indicate what post work summarization took place. Indicate if you had participants at the workshop help write, rewrite, revise, etc. any of the vital sign narratives.

3b. Provide final Vital Sign Narratives for each of the high priority vital signs.

Post Workshop Activities (Continued)

Included on the following pages are the reports from each respective workshop ecosystem group:

FINAL REPORT
ERMN VITAL SIGNS PRIORITIZATION WORKSHOP
TERRESTRIAL ECOSYSTEMS WORKING GROUP

By

Ray R. Hicks, Professor of Forestry, West Virginia University

PRELIMINARY WORK

Prioritization Criteria

The primary activities conducted prior to the May 19- 20 workshop were to reduce the long list of 61 vital signs to a subset that were relevant to terrestrial ecosystems and to select from this list the "high priority" vital signs.

This two-step process involved: first deciding which of the original vital signs were relevant to terrestrial ecosystems, and secondly determining which of these would be considered high priority. For the first step, the decision was clear cut for many of the vital signs. For example, vital signs relating to water quality such as Vital Signs 13, 16 and 17 (Table 1). But some, such as those related to air and climate (VS 2 and 4) affect both aquatic and terrestrial systems; therefore they are relevant to more than one working group. In the final analysis, for the Terrestrial Working Group, I considered as relevant all the vital signs from the following Level1 Groups (Table 1): Air and Climate, Geology and Soils and Ecosystem Pattern and Process. In addition, all except VS 23, 28, 29 and 39- 47 in the Biological Integrity group were considered. In the Level 1 group, Human Use, Vital Signs 51 and 54- 56 were considered relevant to terrestrial ecosystems. In total, 44 of the 61 vital signs were selected for consideration for the high priority short list. In the next step, this list of 44 was further reduced to the high priority list. Criteria used to make this selection were as follows:

- There I a strong defensible linkage between the vital sign and the ecological function or critical resource it is intended to represent.
- The vital sign represents a resource or function of high ecological importance.
- The vital sign provides early warning of undesirable changes to important resources.
- The vital sign is sufficiently sensitive to detect the specified changes (high signal-to-noise ratio) and does not exhibit large, naturally occurring variability.

Developing the Short List

To facilitate the selection process, I classified the vital signs in the terrestrial long list as "stressors" or "indicators". Furthermore, the vital signs were classified as to the resources, processes or states they affected or indicated. For example, resources included light, water, mineral nutrients, etc.; processes included succession, nutrient cycling, regeneration, etc; and states include health, vigor, fecundity and diversity. Finally, the vital signs, especially stressors, were classified as controllable or uncontrollable. In developing the short list of high priority vital signs, both stressor and indicator vital signs were included and an attempt was made to include those that affected or indicated a variety of resources and states. Particular weight was given to the stressors that were controllable and for the indicators, weight was given to those that were measurable, sensitive and had a high signal-to-noise ratio. From the long list of 44, 16 were selected for inclusion in the high priority short list. These are shown in Table 1 in bold face and are identified in column 4 as "terrestrial". Eight of the vital signs in the high priority list were considered stressors (VS1, 2, 4, 11, 18, 38, 54 and 58) and eight were considered indicators (VS5, 20, 25, 32, 34, 48, 59 and 61). In some situations VS58 (Landscape Pattern), the vital sign could be considered a stressor, depending on whether or not the changes in landscape pattern were anthropogenic and resulted in an undesirable ecosystem state. Alternatively, long-term changes in landscape pattern could be an indicator of stresses such as global climate change or over population of white-tailed deer.

Developing the Narratives

For the high priority list of 16 vital signs, narratives were prepared using the following outline:

- Title
- Brief description
- Significance/Justification
- Proposed metrics
- Prospective Method(s) and Frequency of Measurement
- Limitations of Data and Monitoring
- Key References

The literature was reviewed and annotated by R. Stockton Maxwell, WVU Division of Forestry Graduate Student, and the narratives were drafted by myself and reviewed by Dr. James Rentch, Visiting Assistant Professor at WVU in the Division of Forestry. After preparing drafts for three vital signs, they were sent to Matt Marshall, Ecologist for the Eastern Rivers and Mountains Network for his review. Based on his comments, these narratives were revised and used as a template for completing the remaining 13 narratives. During this process, a meeting was held in State College, PA for the Core Planning Team. At this meeting, Matt Marshall discussed with us his concept of how the narratives should be structured, and we discussed the agenda for the up-coming prioritization workshop.

The narratives for the terrestrial vital signs were completed prior to April 15, 2005 and reviewed by ERMS personnel. The revised narratives were forwarded to the participants in the Terrestrial Ecosystems Working Group (Table 2). These individuals represented specialties ranging from biology, climatology, ecology, entomology, geography, herpetology, landscape architecture, mammalogy, soil science and wildlife biology. There were a total of 20 participants in the Terrestrial Ecosystems Working Group.

THE WORKSHOP

Setting the Stage

The prioritization workshop took place over a two-day period in State College, PA. The goals for the working groups were to finalize the short lists of vital signs and to prioritize them into tier 1, 2 and 3 priorities. The workshop began with a brief presentation to the combined working groups by Mat Marshall in which he provided a historic background for the National Park Service's ecological Monitoring Program. In addition, he briefly outlined the expected outcomes of the workshop as well the recommended process for achieving these outcomes. Following this presentation the three working groups (Terrestrial, Large Rivers and Tributary Streams) separated into break-out sessions. My role was to facilitate the functions of the Terrestrial Ecosystems Working Group (see Table 2), aided by Dr. James Rentch and Stockton Maxwell. The first order of business was to introduce the facilitation team, to describe the preliminary work that had been done and to present to the group a brief overview of the process we would utilize to accomplish the goals of the workshop. After completing this presentation, all members of the working group were invited to introduce themselves, to describe their background and to indicate how they expected to contribute to the final product (the ranked priority list of vital signs).

Finalizing the Short List

The preliminary sessions of the workshop were completed by mid morning of the first day, after which we turned our attention to finalizing the short list of high-priority vital signs. Although the narratives for the 16 proposed high-priority vital signs had been previously distributed to the participants, we briefly reviewed the list again. The process was accomplished in two phases. First, we went through the proposed vital signs, one at a time, and decided if any of them should be deleted from the proposed list. Secondly, we determined if any of the original 61 vital signs had been omitted that should be incorporated in the final short list.

The first phase was accomplished by reviewing the vital signs on the proposed short list, one at a time, beginning with a brief justification as to why they had been selected for inclusion and proceeding to a discussion of the vital sign among the participants. This generated lively discussions on many of the vital signs. At the conclusion of discussions for each vital sign, the group was polled as to whether or not the vital sign should be retained on the short list. As a result of this process, three vital signs were dropped from the short list. These were Phenology (VS5); Lichens, Liverworts, Mosses and Bryophytes (VS23); and White-tailed Deer (VS38). Two of these were indicator vital signs (VS5 and 23) and VS 38 was classed as a stressor. A substantial amount of discussion led to the deletion of these three vital signs and although it is not possible to capture it all in a few brief paragraphs, I will attempt to report the gist of the discussions. For VS5 the discussion concluded that phenology may be a valuable indicator for long-term global climate change, but to be useful in the context of ecological monitoring of ERMN parks, data would have to be collected for many decades (perhaps centuries) in order to detect trends. In the short term, normal year-to-year weather fluctuations would mask trends, so a relatively low signal-to-noise ratio exists for phenological data as a predictor of ecosystem trends. Regarding VS 23, it was acknowledged that some of these plants are sensitive to changes in air and climate phenomena such as acid deposition, ozone and global climate change. But here again, the signal-to-noise ratio, the signal-to-noise ratio is relatively low and these organisms may be influenced by a number of other naturally-occurring factors such as overstory canopy changes that occur due to successional trends or natural disturbances (wind, fire, ice, treefall gaps, etc.). For white-tailed deer (VS38), the group acknowledged that deer browsing exerts a profound effect on ecological processes such as forest regeneration and may

be partly or totally responsible for long-term species changes within the ERMN region. But wildlife biologists and mammalogists in the group pointed out that it is difficult, perhaps impossible to obtain affordable and reliable census data on deer populations. Furthermore, the ERMN parks are surrounded on all sides by non-jurisdictional lands, thus regulating deer populations on NPS lands alone may not have much effect on the functional impact of deer in the parks.

The next step in the process was to revisit the vital signs in the original long list of 61 to determine if any should be added to the short list. Table 3 shows the short list of 17 that resulted after deletion of three and addition of 4 new vital signs. As can be seen in Table 3, all the added vital signs were multiples of two or three of the original 61. In two cases, the new vital sign involved broadening a vital sign by incorporating a new one with an existing one. This was true for VS20/28 where Riparian Plant Communities (VS28) was added to Forest Plant Communities-Structure and Demography (VS20). The group's opinion was that riparian zones often blend into upland plant communities in the ERMN region in a manner that makes the separation of the two communities artificial and needless, especially at the tributary/terrestrial interface. Likewise, the group felt that VS57 (Land Cover-Land Use Change) should be combined with VS58 Landscape Pattern). The consensus of the group was that human activities such as development, roading, agriculture, etc. are a dominant factor in the changing landscape pattern of ERMN landscapes. Indeed, the National Park lands are part of a larger landscape, much of which is profoundly affected by human activities. Many times the effects of these activities spill over into the parks. Examples of this are introduction of exotic invasive species, anthropogenic fires, air and water pollution.

Two new vital signs were added to the short list that contained combinations of the original 61, none of which were on the previous short list. These were VS49/50 (At-Risk Species and Communities) and VS30/33/35 (Terrestrial Mammals). The rationale for including the at-risk species and communities was principally based on the fact that many unique T&E species and communities, in addition to their rarity, are highly sensitive and vulnerable to ecosystem perturbations, thus they may provide an early warning mechanism for identifying ecosystem changes that may threaten other communities if the change progresses. In addition, the group saw no reason for separating state and federally listed species, a distinction that appeared to be more political than ecological. Finally, the last new vital sign added was a combination of VS 30, 33 and 35. These were all related to mammalian populations (riparian mammals, bats and Allegheny woodrat). The reasons expressed for combining them were similar to those given for choosing the at-risk species and communities, namely, they are relatively sensitive species that could serve as early warning signals for potentially damaging ecosystem changes. Furthermore, it was pointed out that plants, arthropods and herps were already well represented on the current short list whereas mammals were not.

Prioritizing The Vital Signs

The process of producing a final short list consisting of 17 vital signs was completed at the end of the first day of the workshop. The second day's activity was to focus on creating a three-tier ranking for the vital signs on the short list. Workshop participants were reminded by the organizers as to the criteria that should be used for the prioritization process (as stated in the initial section of this report). Following that a brief discussion of the 17 remaining vital signs took place in order to remind participants what they represented and to give a final opportunity for people to express their opinions and thoughts. Following this, the group discussed what mechanism we would use in order to develop the priority ranking. It was decided that the participants would, by ballot, vote on each vital sign as to whether they believed it to be tier 1, 2 or 3. No set number of vital signs was stipulated in each tier, but participants were instructed to make an effort to rank some vital signs in each category. The process used to evaluate the combined ranking was to sum all the scores of the participants for each vital sign (tier 1= 1, tier 2= 2, tier 3= 3). The final tier ranking was based on these summary rankings, with the breaks between tiers being defined by

obvious breaks in the summary rankings. We also looked at the frequency that a specific vital sign was ranked in a specific tier as an aid to establishing the final ranking. The first time we applied the above procedure, the list of tier 1 vital signs consisted of five, but none of them were related to weather and climate, an area that many of us felt was important, and should have been ranked higher. After discussions among the workshop participants and consultation with Matt Marshall, it was decided to conduct a re-vote. The second vote took place after the general session where all three working groups had an opportunity to present and discuss their rankings. Based on the re-vote, five vital signs were assigned tier 1 status (Table 4). These were VS20/28, (Plant Communities- Structure and Demography/Riparian Plant Communities); VS57/58 (Land Cover/Land Use Change/Landscape Pattern); VS18 (Invasive Plants, Animals and Diseases- Status and Trends); VS2 (Air Chemistry- Wet and Dry Deposition, Contaminants); VS32 (Breeding Bird Communities). Among these, three were considered "indicators" (VS20/28, VS57/58 and VS32) and two were considered "stressors" (VS18 and VS2). They represent a variety of level categories including Air and Climate, Biological Integrity and Ecosystem Pattern and Process.

POST-WORKSHOP ACTIVITIES

Since completing the workshop Stockton Maxwell has refined the transcript of the proceedings of the Terrestrial Working Group sessions at the workshop and has developed tabulations of the final votes and rankings of the vital signs in our final short list. Jim Rentch and Matt Marshall are in contact regarding the development of a Terrestrial Ecosystems Conceptual Model and is starting to work on producing a visual model. Previously-developed narratives of the vital signs on the short list have been routed to reviewers who have specific knowledge and background for their comments and I have been assigned the task of developing new narratives for new vital signs that were added at the workshop (generally combinations of previously-included vital signs or new ones added to the short list). In the case of a couple of vital signs that were added to the short list during the workshop, no narrative was done. In these cases, reviewers were askes to develop a narrative. The final edited and approved narratives are included in Appendix X (to be added).

Finally, this report was produced with extensive help from Stockton Maxwell, Jim Rentch and Matt Marshall. It is intended to document the purpose, process and results of a vital signs assessment workshop for the ERMN parks and it provides the park managers with a prioritized list of vital signs that should serve as the basis for an ecological monitoring program.

Workshop Report – Tributary Watersheds

By

Dr. Rob Brooks Cooperative Wetlands Center
Pennsylvania State University

1. Work prior to workshop

Based on direction from staff of the Eastern Rivers and Mountains Network, an experienced team of three scientists was assembled to prepare a literature-based narrative that addressed conceptually, the structure and function of tributary watersheds, including stream, wetlands, and riparian components (Brooks et al. 2005). All members of the team contributed to the document which focused on tributary watersheds as holistic ecosystems.

When the document was in near final form, the three members of the team independently reviewed the preliminary list of 61 Vital Signs to develop a short list of candidates. The team compared the three lists and arrived at a consensus list of 18 candidate signs, including one new one that was not on the original list – digital soils data. These were ranked as highest or moderate priority to provide workshop participants with an indication of their relative importance. A 1-2 page narrative about each Vital Sign was prepared. Decisions about which Vital Signs were most important and relevant was based on the team's experience in working in these ecosystems coupled with a review of the literature. Selections were guided by the realization that potential Vital Signs must reflect the ecological integrity of these critically important ecosystems, and that they be realistically and efficiently measured. The team believed that an emphasis should be placed on the important biological endpoints, with supporting information about the physical, chemical, and landscape characteristics of tributary watersheds. The Vital Signs selected were designed to assess the condition of biological resources and to diagnose stressors of these resources.

Working with ERMN staff, a list of workshop invitees was developed. The conceptual narrative on tributary watersheds, the vital sign narratives, and a table of all 61 Vital Signs, with the pertinent ones for tributaries bolded, was provided to workshop participants prior to the May 2005 workshop in State College, Pennsylvania.

2. Workshop

At the opening session of the workshop, Brooks presented a brief Powerpoint presentation to all workshop participants that introduced tributary watershed concepts and listed the 18 potential Vital Signs on the short list. During the tributary watershed session, participants were introduced (n=X), and then each recommended Vital Sign was discussed individually. Participants were encouraged to provide reasons why each potential Vital Sign should be included in the final short list. The proposed list of 18 provided a focus for the discussions, but any other Vital Signs (n=61) on the overall list were eligible for inclusion. As long as at least one participant

expressed a strong preference to include a Vital Sign on the evolving short list, it was included initially for further discussion.

After the new short list was assembled, a "straw vote" was held to determine the strength of support for all Vital Signs on the list. This "winnowed" list was then discussed further Finally, participants voted in an open forum to establish a priority list of Vital Signs with rankings of 1, 2 or 3. This information was reported in the final general session at the end of the first day. The final list of recommended Vital Signs for tributary watersheds included 11 in the first tier, 8 second tier (with one new Vital Sign – Indicator Taxa), and 2 in the third tier, for a total of 21 (Table 1).

During the morning of the second day of the workshop, the tributary group re-visited the recommended list of 21 Vital Signs, and discussed possible methodology and measurement issues before adjourning. In addition, some effort was made to group selected Vital Signs into logical sub-groupings that should be sampled as a coherent unit. For example, participants suggested that Water Quality Core & Enhanced Parameters (16 & 17), Stream/River Channel Characteristics (7), and Aquatic Macroinvertebrates (39) should be sampled together as a suite. Thus, biological, chemical, and physical aspects would be sampled as a cohesive unit. Participants believed that this approach would mesh well with park unit programs tied to Clean Water Act requirements. The participants also grouped the landscape related Vital Signs (Land Cover/Land Use – 57, Landscape Pattern – 58) together because their measurements are intertwined, and there is no loss of efficiency in considering both simultaneously. These were considered essential for diagnosing stressors. There is a lack of hydrologic data for small streams and wetlands, so participants indicated that Surface Water Hydrology (13) and Wetland Hydrology (14) should be of high priority. This should be done by selecting representative examples of both types of aquatic ecosystems; it need not be comprehensively implemented. Standard stream gages plus crest gages were suggested for streams, whereas slotted wells and crest gages would work for wetlands.

3. Post Workshop

The narratives for several potential Vital Signs were revised based on comments received during the workshop, and a new one was written for T&E and Indicator Taxa. No participants indicated a strong interest in reviewing the workshop summary for tributary watersheds. Copies of the summary were sent to all participants.

Literature Cited

Brooks, R.P., C. Snyder, and M. M. Brinson. 2005. Conceptual model of tributary watersheds with associated wetlands and riparian areas. Unpublished manuscript. 38pp.

Eastern Rivers and Mountains Network
Vital Signs Prioritization Workshop
May 19-20, 2005

Large River Ecosystem Working Group
Final Report

William Lellis U.S. Geological Survey
Wellsboro, PA

1. Work Prior to the Workshop

1a: A comprehensive list of potential vital signs (61 total) was received from the NPS ERM I&M coordinator for use in developing a prioritized list for inclusion into a large rivers monitoring program within the ERM Network.

1b. The candidate list of all vital signs was reduced to only those previously ranked by the NPS as having relevance to large river systems (36 total, see Table 1).

VS: 2, 4, 5, 6, 7, 11, 13, 14, 15, 16, 17, 18, 19, 23, 28, 29, 30, 37, 39, 40, 41, 42, 43, 45, 48, 49, 50, 52, 53, 54, 55, 57, 58, 59, 60, 61.

1c. A list of potential purposes for a riverine monitoring program was developed (see Table 2), and three individuals at the USGS Northern Appalachian Research Lab, Wellsboro, PA (William Lellis, Robert Ross, Martin DiLauro) reviewed and rated each vital sign based on ecological significance towards understanding riverine systems and the potential value to a monitoring program. The list was also sent to four individuals for additional review and comment (Bob Hilderbrand, U. Maryland; Karen Riva Murray, USGS; Paul Angermeier, Virginia Tech; Peggy Johnson, Penn State).

A literature review was conducted and a conceptual model developed based on concepts presented by James R. Karr in *Defining and measuring river health, Freshwater Biology (1999) 41:221-234* (see Fig. 1). The model is based on the concept that both natural factors and human activities affect the physical, hydrological, and chemical characteristics of the river. In combination, these abiotic factors shape the structure and distribution of biological communities, which can themselves be analyzed to infer the environmental conditions in which they live. Undesirable changes in biological communities would lead to policy or actions intended to alter human activities that negatively impact the physical, hydrological, or chemical environment. This feedback loop was considered to be an important element of a monitoring program based on the assumption that the NPS would want to use monitoring information to protect and preserve park resources, rather than simply document change over time.

A short list of vital signs was then developed for consideration into a riverine monitoring program. The list was designed to include at least one indicator each of the geological, hydrological, chemical, and biological condition of the system; one indicator each of the most likely natural and human influences on the system; and one early warning indicator of potential health hazard to park visitors. Indicators were only considered in the context of the river systems within ERM network parks (DEWA, UPDE, NERI, GARI, BLUE). The short list was arbitrarily limited to 10 vital signs based on the assumption that rivers would only be a portion of the total monitoring program, and finances and manpower would be constrained. Relevance to all riverine parks was considered, and the riparian zone was considered part of the river system. Vital signs were not prioritized within this short list, outside of inclusion or non-inclusion. The 10 proposed vital signs are listed above the break line in Table 1.

Short List VS: 4, 7, 13, 16, 17, 28, 39, 45, 52, 57.

1d. Rationale for inclusion in the short list:

VS-7, river channel geomorphology: The most important geological determinant of river and riparian character that can be altered by natural and human influences. Of particular importance is sediment transport and deposition. Intended to be monitored at long intervals or after major events.

VS-13, surface water hydrology: The most important hydrological determinant of river and riparian character that can be altered by natural and human activities. Of particular importance to the ERM network due to water withdrawal, containment, and release from impoundments on mainstem and tributaries. Long-term data sets and ongoing monitoring programs by USGS.

VS-16, water quality core parameters: The most important chemical determinant of riverine character, largely altered by human activity. Core parameters are currently monitored at all parks through ongoing program.

VS-17, water quality expanded parameters: Indicators of specific human activities such as agriculture, development, and industry. Of particular importance is nutrient loading and fecal coliforms.

VS-39, aquatic macroinvertebrates: Most robust indicator of cumulative physical and chemical impacts on biological communities. Monitoring techniques are standardized and well-developed. Many matrices available. Ongoing federal and state programs.

VS-45, fish communities: Higher level indicator of biotic integrity. Also indicator of park natural resource usage and general detection of invasive species. Can be tied to contaminants and aquatic animal disease monitoring programs.

VS-28, riparian plant communities: Most important indicator of riparian zone biological integrity. Detection of riverine biodiversity. Particularly important in detection and monitoring of riverine invasive species.

VS-52, bioaccumulation of toxins: A practical means of monitoring toxic compounds and metals that exist in low concentrations or are pulsed through the ecosystem. Indicator of potential health risk to park visitors.

VS-4, weather and climate: The most important natural influence on riverine conditions. Long-term data sets available and ongoing federal and state monitoring programs. Data needed to separate natural variation from human-induced change.

VS-57, land cover and land use change: The most important human influence on riverine conditions in ERM parks outside of water management through impoundments. Changes in land use and development outside park boundaries are likely to have major impact on park resources over the next century. Parks will need this information to interact with local community planning boards.

Rationale for omission from the short list:

VS-2, air deposition: Potentially important source of inorganic pollutants to river systems, but probably less impact than point sources. Air deposition is likely more damaging to terrestrial and tributary systems than large rivers.

VS-5, phenology: Biological rhythms may be sensitive indicators of environmental change, but too little is known of aquatic cycles or natural variation within those cycles. More appropriate for directed study than monitoring.

VS-6, landslides: Landslides can alter channel geomorphology, water flow, and sedimentation patterns and thus may be important in understanding changes in river ecosystems. However, landslides and their impacts would likely be detected during geological (VS-7), water quality (VS-17), and perhaps land cover (VS-57) monitoring programs.

VS-11, soil erosion: Like the primary contributor of sediments in eastern river systems (along with bank erosion, and to a lesser degree, landslides), and thus is an important factor in understanding river ecology. However, the NPS may be better served by including a direct measurement of sedimentation into the monitoring program (VS-7, VS-17), then conducting source studies if unacceptable loads are detected.

VS-14, wetland hydrology: Wetlands were not considered by the river ecology group under the assumption that they would be addressed by either the terrestrial or tributary group.

VS-15, groundwater hydrology: Groundwater input is likely a very important component of eastern river ecology as a source of flow, nutrient input, and thermal refuge during winter and summer. However, ground water input and impact is very difficult and costly to

quantify, and thus may be more appropriate for directed studies rather than inclusion into an overall river monitoring program.
VS-18, invasive species status and trends: From a biological perspective, invasive species are one of the most disruptive factors in eastern river ecology, and should thus be considered for inclusion in a monitoring program. Within ERM network parks, most recognized problematic invasives are either fish or riparian plants. VS-18 was not included in the rivers short list under the assumption that some information on these invasives would be obtained through inclusion of VS-28 and VS-45. A complicating factor in ERM parks is that many, if not most of the game fish are invasive species whose populations are managed and encouraged by state resource agencies for recreational fishing.

VS-19, invasive species early detection: Early detection of invasive species is both complicated from a program design perspective and expensive from a manpower perspective. VS-19 was not included in the rivers short list under the assumption that some new invasives may be detected through inclusion of VS-28, 39, and 45, and that early detection of invasives is more appropriately addressed through a stand-alone program than by inclusion in long-term monitoring.

VS-23, wetland plants: Wetlands were not considered by the river ecology group under the assumption that they would be addressed by either the terrestrial or tributary group.

VS-29, riparian birds: The rivers preliminary group was not aware of any specific issues related to riparian bird communities within ERM parks, nor how riparian birds could serve as general indicators of ecosystem status considering the multitude of factors outside the riverine environment that could affect population size and distribution of these transitory species.

VS-30, riparian mammals: The rivers preliminary group was not aware of any specific issues related to riparian mammal communities within ERM parks, nor how riparian mammals could serve as general indicators of ecosystem status. Mammal populations may be more appropriately studied through either inventory programs or targeted investigations.

VS-37, migratory animals: Several migratory fish are of interest to the Delaware River parks, such as eels, shad, and striped bass. However, population status and trends in the parks are poorly understood and a multitude of factors beyond the riverine environment may affect their distribution and abundance. More appropriate for study through either inventory programs or targeted investigations.

VS-40, freshwater mussels: May be an important indicator of water quality and can alter ecosystem function through filtration and energy partitioning. Mussel populations have been extensively studied in the Delaware River parks, but the amount of variance over time is unknown, and the causes and implications of fluctuations are too poorly understood to consider inclusion in a general monitoring program unless the purpose is to simply document status and trends for future reference. Freshwater mussels (specifically *Elliptio complanata*) may be considered a “keystone species” in some ERM parks due to abundance

and potential ecological impact. Mussels could be incorporated into a contaminants monitoring program (VS-52).

VS-41, crayfish: The rivers preliminary group was not aware of any specific issues related to crayfish communities within ERM parks, nor any work using crayfish as general indicators of ecosystem status. Crayfish may be important to riverine ecology due to benthic foraging behavior, but causes and implications of population variation over time are poorly understood. There is potential concern for spread of the invasive rusty crayfish into ERM parks, but monitoring may accomplished through VS-39 or VS-45.

VS-42, aquatic periphyton: Benthic algal communities may be sensitive indicators of human impact to eastern rivers due to their abundance in lotic systems, immobility, and adaptability to a wide range of ecological conditions. Although they have potential as a powerful tool in aquatic monitoring programs, they were not included in the riverine short list because less research has been done to develop regional or basin level metrics or to test dose-response gradients to human influence than have been developed for macroinvertebrate (VS-39) and fish (VS-45) communities.

VS-43, macrophytes: The rivers preliminary group was not aware of any specific issues related to macrophyte communities within ERM parks. Macrophyte density and distribution tends to fluctuate extensively in ERM parks both intra- and inter-seasonally, making a general monitoring protocol difficult to design and interpret. Biological response to aquatic conditions might better be monitored through VS-39 or VS-42.

VS-48, reptiles and amphibians: The rivers preliminary group was not aware of any specific issues related to reptile and amphibian populations within the rivers of ERM parks. The causes and ramification of a widespread decline in amphibian populations is of national interest, but more appropriately addressed by the terrestrial or tributary monitoring groups.

VS-49, State T&E species: The rivers preliminary group felt that endangered species issues would be more appropriately addressed through park-specific population studies than through a general monitoring program.

VS-50, Federal T&E species: The rivers preliminary group felt that endangered species issues would be more appropriately addressed through park-specific population studies than through a general monitoring program.

VS-53, fish and wildlife harvest: Not included in short list because of assumption that wildlife harvest is regulated, licensed, and monitored by the States. Much of the targeted fish harvest is invasive species (smallmouth bass, walleye, rainbow trout, brown trout). Specific concerns such as commercial eel harvest in the upper Delaware River are better addressed through park-specific projects rather than through a general monitoring program.

VS-54, visitor usage: Impacts by rafters, canoeists, boaters, swimmers, and fishers can be significant in the ERM parks, but VS-54 not included in short list because of assumption

that visitation rates and patterns are tracked through other NPS programs, and impacts such as pollution or siltation would be more directly measured through VS-17.

VS-55, natural sounds: The rivers preliminary group was not aware of any specific ecological issues related to human-generated noise associated with rivers of ERM parks. There may be impacts of noise from river users, airplanes, and trains on the quality of experience by park visitors engaged in riverine activities, but these are better addressed by other NPS programs, such as the Soundscape Program.

VS-58, landscape pattern: Landscape pattern was understood by the rivers preliminary group to refer to patch size and distribution of dominant land cover types, which is of more importance to terrestrial and tributary ecology than to riverine ecology, which would be more influenced by land use and cover (VS-57). However, use, pattern, and cover may be viewed as different analyses of the same data sets, and thus VS-57 and VS-58 might be combined into one vital sign.

VS-59, primary productivity: Accurate and comprehensive calculation of primary productivity for riverine systems of ERM parks was seen as beyond the scope of a general monitoring program and better addressed through stand-alone projects.

VS-60, decomposition: Accurate and comprehensive calculation of decomposition rates in riverine systems of ERM parks was seen as beyond the scope of a general monitoring program and better addressed through stand-alone projects.

VS-61, nutrient dynamics: Components of interest to ERM parks are already addressed in VS-17.

2. Workshop

2a. Draft narratives were prepared for some of the priority vital signs and distributed to the riverine panel prior to the workshop. Draft narratives did not completely match the preliminary list of priority vital signs due to final adjustments made to the list just before the workshop resulting from input received from external reviewers (see section 1c).

The workshop began with general introductions and goals by the ERM I&M Coordinator followed by break-out of focus groups. The riverine panel began with participant introductions and a discussion of the conceptual model used to prioritize vital signs. A preliminary short list was presented to the panel with an explanation and group discussions of why each vital sign was selected for the list. No vital signs were removed from the short list as a result of this process.

2b. Each vital sign not selected for inclusion in the short list was discussed in detail and group consensus was reached on whether those vital signs should or should not be included in the short list. This process resulted in an additional four vital signs being moved into the short list that were previously omitted (final list 14 total, see Table 3).

Additional VS: 15, 41, 42, 43.

VS-15, groundwater hydrology: Moved to short list because of importance to river ecology and potentially significant impacts from predicted development outside park boundaries. However, monitoring proposed only to the extent that data can be obtained from other agencies, not seen as an NPS-funded project due to projected expense.

VS-41, crayfish: Moved to short list because of potential importance to benthic community structure and rapidly spreading distribution of invasive rusty crayfish poised to enter eastern parks.

VS-42, aquatic periphyton: Moved to short list because of recent work by EPA and others in developing sensitive metrics applicable to ERM parks.

VS-43, macrophytes: Moved to short list because macrophytes may be a better indicator than other biological communities of nutrient enrichment and sedimentation released from upstream impoundments.

2c. Each panel member was then asked to anonymously rate each of the 14 vital signs as to whether it should be ranked as Tier-1, 2, or 3, with Tier-1 being highest priority for inclusion into a monitoring program to detect changes in river ecology and identify cause of change, Tier-2 being important additional information helpful but not critical to understanding river ecology, and Tier-3 being important to understanding certain park-specific ecological issues, but not critical to all parks in the ERM network. Vital signs were then ranked based on the sum total of Tier rankings by each of the 15 panel members (see Table 4).

VS Ranking: 16, 39, 45, 13, 57, 17, 42, 7, 4, 52, 28, 41, 43, 15.

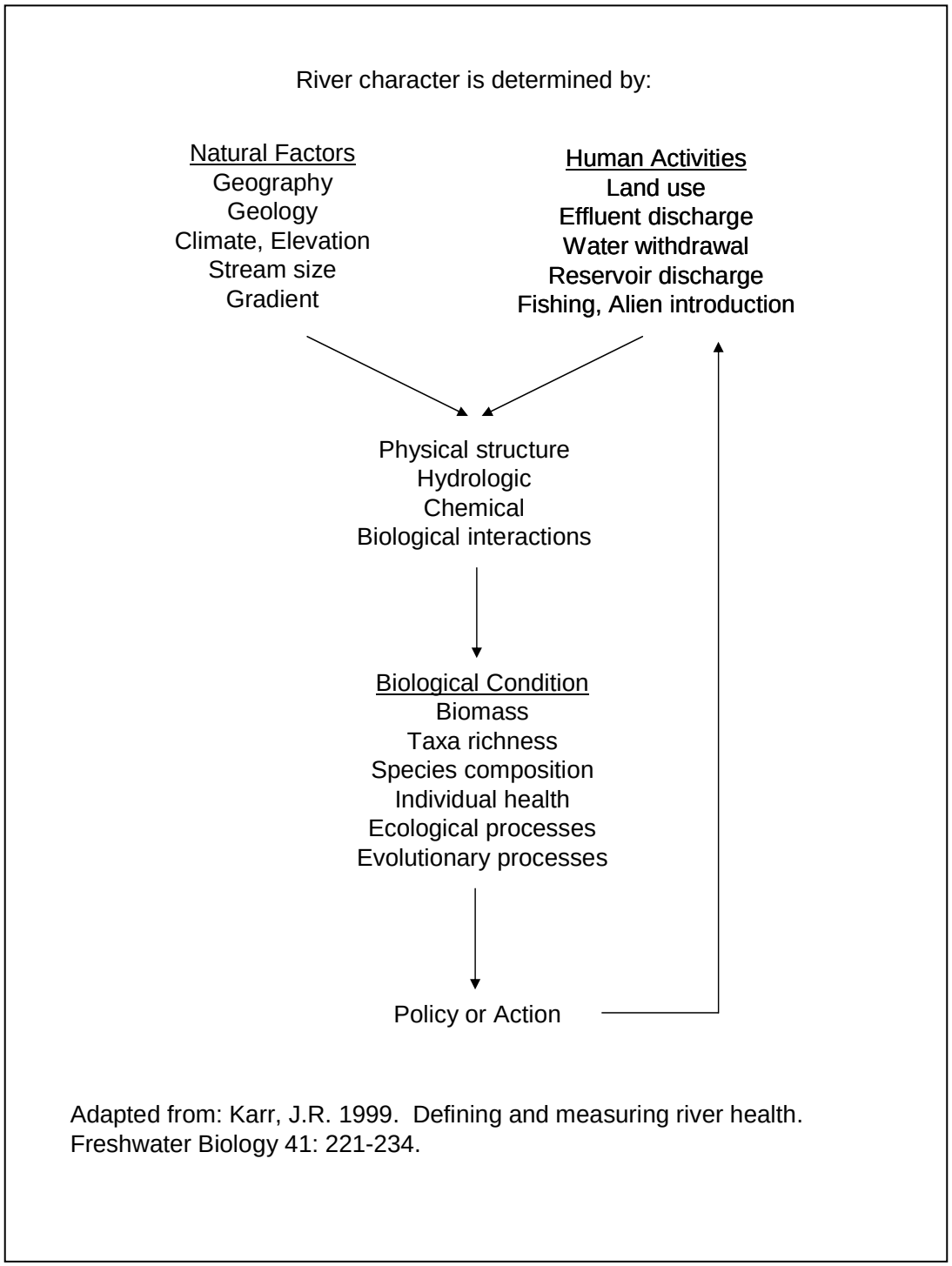
2d. Final classification into Tier-1, 2, and 3 ranking was done by group discussion and consensus based on sum, mean, and proportion of votes for each rank. Following presentation to the entire group and overnight deliberations, the panel reviewed the Tier rankings and made final adjustments based on group consensus without the need for additional individual voting (see Table 4).

Tier-1 VS: 16, 39, 45, 13, 57.
Tier-2 VS: 17, 42, 7, 4, 52, 28.
Tier-3 VS: 41, 43, 15.

Table 2. Potential purposes of a large river monitoring program.

1. Document current condition.
2. Monitor change over time.
3. Evaluate human impact.
4. Determine sources of impacts.
5. Monitor specific know stressors.
6. Monitor predicted future stressors.
7. Monitor biological condition.
8. Monitor keystone species.
9. Monitor target species of interest.
10. Monitor threats to park visitors.

Figure 1. Conceptual model for prioritizing vital signs for large river ecosystems.



Adapted from: Karr, J.R. 1999. Defining and measuring river health. Freshwater Biology 41: 221-234.

Park Management Significance Rankings

Following the prioritization workshop based on ecological significance, we distributed the short list of network vital signs to solicit input from park staff once again. Parks were presented with the short list of vital signs from all three ecosystem types resulting from the workshop and asked to prioritize these vital signs according to management significance and legal mandate. Park staffs were not presented with results of the tier rankings based on ecological significance done at the workshop. Evaluation of each vital sign in terms of management significance was done according to the criteria and scoring laid out in the proposed Prioritization Process included above.

While much of this thought process went into the generation of the original candidate list of 61 vital signs, the park staffs never had an opportunity to explicitly rank each vital sign based on management priorities. The criteria and scoring of each would result in a total score ranging from a low of 4 to a high of 12.

Park staffs were encouraged to rank only the list of 36 provided to them, but certainly could propose that a new vital sign be added to the list (only one was added: Aquatic macroinvertebrates: Mussels).

Once this park ranking process was underway, it became clear that it would also be useful for the parks to report management significance scores in the simple "tier 1-3" framework as was done at the workshop. Thus, each park ultimately provided scores under both ranking systems. In addition to providing raw scores and rankings, park staff was asked to write a short narrative communicating why each vital sign was deemed important to park management, or of lesser importance.

The results of the park management significance ranking exercise largely supported vital signs rankings from the workshop. Two vital signs (both ranked tier 1s from the workshop), received perfect scores of 12 across all parks (VS#s 16 and 17; "Water Quality – Core Parameters" and "Water Quality – expanded parameters"). Five vital signs came out of the park management significance ranking with a mean park ranking of 11, two of which were ranked tier-twos from the workshop (VS#s 49-50, "State T&E Species and Species of Special Concern", and "Federal T&E Species"). Three vital signs received vital sign ranks of five which was the lowest mean score received (VS#s 41, 52 and 61; "Aquatic macroinvertebrates – crayfish", "Bioaccumulation of toxins/contaminants" and "Nutrient dynamics"). Of these three lowest park ranked vital signs two were ranked tier-two from the workshop and one was ranked tier-three (out of 8 total tier-threes from the workshop). VS#s 48 and 61 (Reptiles and Amphibians and Nutrient Dynamics), were the only two vital signs to receive the lowest possible score (4) from more than one park. Overall there was a very clear distinction between vital signs among respective park management significance rankings, especially among the most preferred vital signs.

A table with park and workshop rankings follows. (Complete Park scoring and rankings along with narratives can be accessed on the ERMN network website: (http://www1.nature.nps.gov/im/units/ermn/index.htm)

Table K.1 Vital Signs for the Eastern Rivers and Mountains Network presented in the national 3-category framework with associated ecological and management significance rankings. “Final” refers to the final network rank based on an assimilation of the workshop ecological significance ranking process (“Workshop”) and the respective park management significance ranking process (“Park Codes”). Tier-rankings (1 = highest, 3 = lowest) refer to the suggested priority in which vital signs should have protocols developed and implemented.

			Tier Ranks (Final Network Rank, Workshop Rank, and Park Management Ranks)										
Level 1 Category	**Level 2 Category**	**Level 3 Category “Vital Sign”**	**Final**	**Work Shop**	**ALPO**	**JOFL**	**FONE**	**FRHI**	**DEWA**	**UPDE**	**NERI**	**GARI**	**BLUE**
Air and Climate	Air Quality	Ozone	**2**	2	2	2	2	3	3	3	3	3	3
		Wet and Dry Deposition	**1**	1	1	1	3	3	2	2	2	2	2
	Weather and Climate	Weather and Climate	**1**	2	1	2	3	3	2	3	1	1	1
Geology and Soils	Geomorphology	Stream/River Channel Characteristics	**2**	1.5	3	3	2	2	2	2	1	1	1
	Soil Quality	Soil Erosion and Compaction	**3**	3	3	3	3	3	3	3	2	2	2
		Soil Function and Dynamics	**2**	2	3	3	3	3	3	3	2	2	2
Water	Hydrology	Surface Water Dynamics	**1**	1	2	2	3	3	1	1	1	1	1
		Wetland Water Dynamics	**1**	1	2	1	1	2	3	3	2	2	2
		Groundwater Dynamics	**2**	3	3	3	1	2	3	2	2	2	2
	Water Quality	Water Chemistry - Core	**1**	1	1	1	1	1	1	1	1	1	1
		Water Chemistry - Expanded	**1**	1.5	1	1	2	1	1	1	1	1	1
		Aquatic Macroinvertebrates	**1**	1	2	2	1	1	1	1	1	1	1
		Aquatic Periphyton	**3**	2.5	3	3	3	3	3	2	3	3	3
Biological Integrity	Invasive Species	Invasive/Exotic Plants, Animals and Diseases – Status and Trends	**1**	1.5	1	1	1	1	1	1	1	1	1
		Invasive/Exotic Plants, Animals and Diseases – Early Detection	**1**	2	1	1	1	1	2	1	1	1	1
	Focal Species or Communities	Shrubland Forest and Woodland Communities	**1**	1	1	1	3	3	1	2	1	1	1
		Riparian Communities	**1**	1	2	1	1	1	2	2	2	2	2
		Birds - Riparian Communities	**2**	2	2	2	1	1	2	3	2	2	2
		Mammals – Riparian Communities	**3**	3	3	3	3	3	3	3	2	2	2
		Birds – Breeding Communities	**1**	1.5	1	2	2	2	3	3	1	1	1
		Terrestrial Invertebrates	**2**	2	3	3	3	3	3	3	2	2	2
		Freshwater Communities - Mussels			.	.	.	.	.	.	.	.	.
		Freshwater Communities - Crayfish	**3**	3	3	3	3	3	3	3	2	2	2
		Freshwater Communities - Macrophytes	**3**	3	2	2	3	3	3	2	3	3	3

			Tier Ranks (Final Network Rank, Workshop Rank, and Park Management Ranks)										
Level 1 Category	**Level 2 Category**	**Level 3 Category "Vital Sign"**	**Final**	**Work Shop**	**ALPO**	**JOFL**	**FONE**	**FRHI**	**DEWA**	**UPDE**	**NERI**	**GARI**	**BLUE**
		Fish Communities - Streams	**2**	2	2	2	3	3	3	2	2	2	2
		Fish Communities - Rivers	**2**	1	3	3	3	3	2	1	2	2	2
		Amphibians and Reptiles – Vernal Pond Community	**2**	2	2	3	2	2	2	3	2	2	2
		Amphibians and Reptiles – Streamside Salamander Community	**2**	2	3	3	2	2	3	3	2	2	2
		Amphibians and Reptiles	**2**	2	3	2	2	2	3	3	1	1	1
	At-risk Biota	T&E Species & Communities - State	**1**	2	1	1	1	1	2	2	1	1	1
		T&E Species & Communities - Federal	**1**	2	1	1	1	1	1	1	1	1	1
Human use	Point-Source Human Effects	Bioaccumulation	**3**	2	3	3	3	3	2	3	3	3	3
	Visitor and Recreation Use	Visitor Use	**2**	3	3	3	3	3	1	2	2	2	2
Landscapes (Ecosystem Pattern and Processes)	Landscape Dynamics	Land Cover and Use	**1**	1	1	1	2	2	1	1	2	2	2
		Landscape Pattern	**1**	1	2	2	2	2	1	2	2	2	2
	Energy Flow	Primary Production	**3**	3	3	3	3	3	3	3	3	3	3
	Nutrient Dynamics	Nutrient Dynamics	**3**	2	3	3	3	3	3	2	3	3	3

Network Summarization and Internal Review

Following the management significance ranking process, ERMN network staff used the computing and discerning power of the human brain to assimilate the workshop (ecological significance) and park (management significance and legal mandate) ranks. It was not possible to take any straight "averages" because not each ecosystem working group at the workshop ranked each vital sign and park managers ranked vital signs using two different ranking systems. As such, network staff took an overarching view of each rank and ranking system to assign the final network rank (Table K.1).

With workshop and park rankings combined there were 15 tier-one vital signs, 13 tier-twos and 8 tier-threes. Of these there was almost universal consensus between parks and the workshop on four of these meaning that they were ranked tier-one from both the workshop and park management ranking (these were vital sign#s 13, 16, 20 and 39). Following closely behind these top-four vital signs were five that received tier-one rankings from parks and from at least one of the workshop groups (these were vital sign#s 4, 17, 18 and 32). Rounding out the final tier-ones were five vital signs that received tier-one rankings from one of the two ranking exercises and a tier-two from the other. Specifically, the "Riparian plant communities" vital sign received the least support of the final tier-one ranks. Conversely, the "Water quality – wetlands" and "Fish communities –rivers" vital signs received a convincing amount of support yet were given a final tier rank of two. There was a clear and convincing amount of support expressed through both ranking processes for all but a few of the final tier-one ranked vital signs.

On the other end of the ranking scale, six vital signs received workshop and park tier ranks of three (these were vital sign#s 11, 30, 41, 43, 59 and 98). One of these ("Terrestrial mammals") along with the "Indicator Taxa" vital signs were dropped by the network coordinator following park rankings due to lack of support and confusion about what they were. Next to the six vital signs given the least amount of support there were eight that received tier rankings of three from one of the ranking processes and two for the other; two of these however, were given final ranks of two based on strength of support expressed through the workshop. Besides the bottom six vital signs there was a lot more mixing of support throughout the bottom ranked vital signs than there was for the top ranked vital signs.

Throughout the tier-two ranked vital signs there was a lot of mixture of support expressed from various parks or one workgroup or another at the workshop. It is very difficult to distinguish between the ten middle ranked vital signs simply based in the ranking processes and results that have been presented here.

As has been stated elsewhere in this report, the tier ranking process was not meant to develop a numeric order in which vital signs would be implemented. That said, it is important to glean as much information from the tier ranking exercise as is possible in order to support future implementation decisions. After ERMN staff had finished compiling the workshop and park rankings they felt that there remained a number of outstanding issues with vital sign rankings that they would present to the SAC during fall 2005 for final resolution. This of course will also need to meet final approval of the ERMN Board of Directors (BOD) too before any action is taken to implement, or not implement protocol development for given vital signs.

Vital Signs for the Eastern Rivers and Mountains Network

Network staff recognizes that all 36 vital signs are important, considered high priority (by definition), and warrant protocol development and implementation. However, the objective of assigning an overall priority rank ("implementation tiers") was to clearly specify with which vital signs the network should move forward on protocol development first. Given financial and logistical realities it is imperative that the network develop the *most* important elements in the program first. It is also likely that the network could spend its entire budget on any one of the identified tier-one vital signs, meaning that cooperation with other agencies and organizations will be of utmost importance. It was clearly verbalized repeatedly throughout the workshop and park ranking processes that the tier ranking system would carry substantial and significant weight for the future direction of the program

In keeping with an idea of doing fewer things better, the ERMN proposes (pending fall 2005 SAC and BOD review and approval) to begin protocol development on those vital signs assigned the tier -1 implementation category first. However, as has been stated it is unlikely that the ERMN budget will even support protocol development for all 15 tier-one vital signs. Network staff will rely heavily on both the amount of support expressed information learned through the prioritization process, but also on input from the SAC and BOD to continue to help us develop and direct this program. Finally, as staffing and budgeting allow, move to tier -2 and -3 vital signs. In several cases it may be possible to efficiently and cost-effectively incorporate several vital signs into a single protocol in which cases lower tier vital signs may be incorporated sooner than their priority rank. In others, the network may collaborate with an existing national monitoring program(s) (e.g., for several of the weather and climate vital signs). And in still other cases tier 2 and 3 vital signs may be elevated to more prompt protocol development based on SAC and BOD guidance. The ERMN will look for all possible efficiencies and collaborations within and outside the NPS to implement as many of the high priority vital signs as possible.